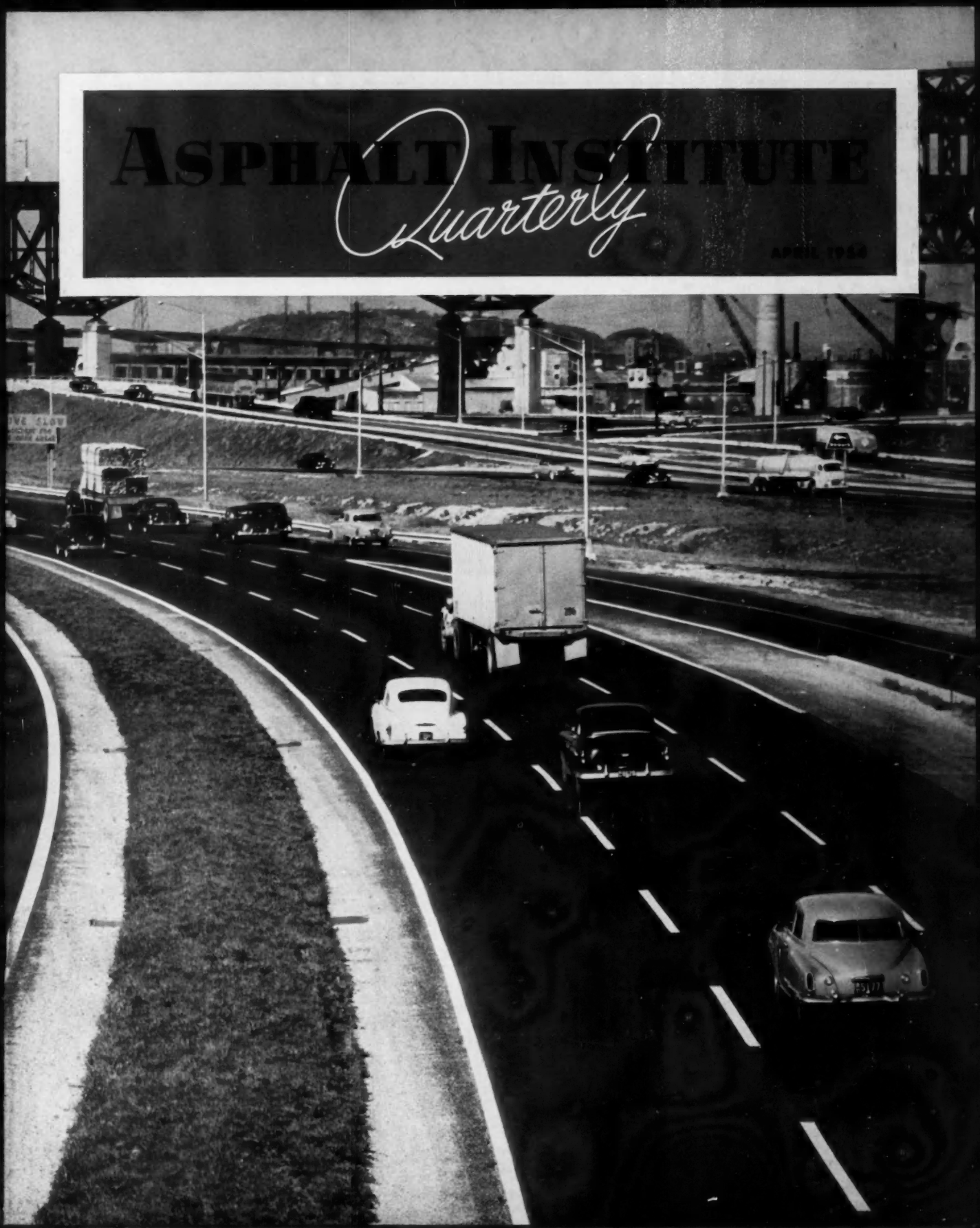
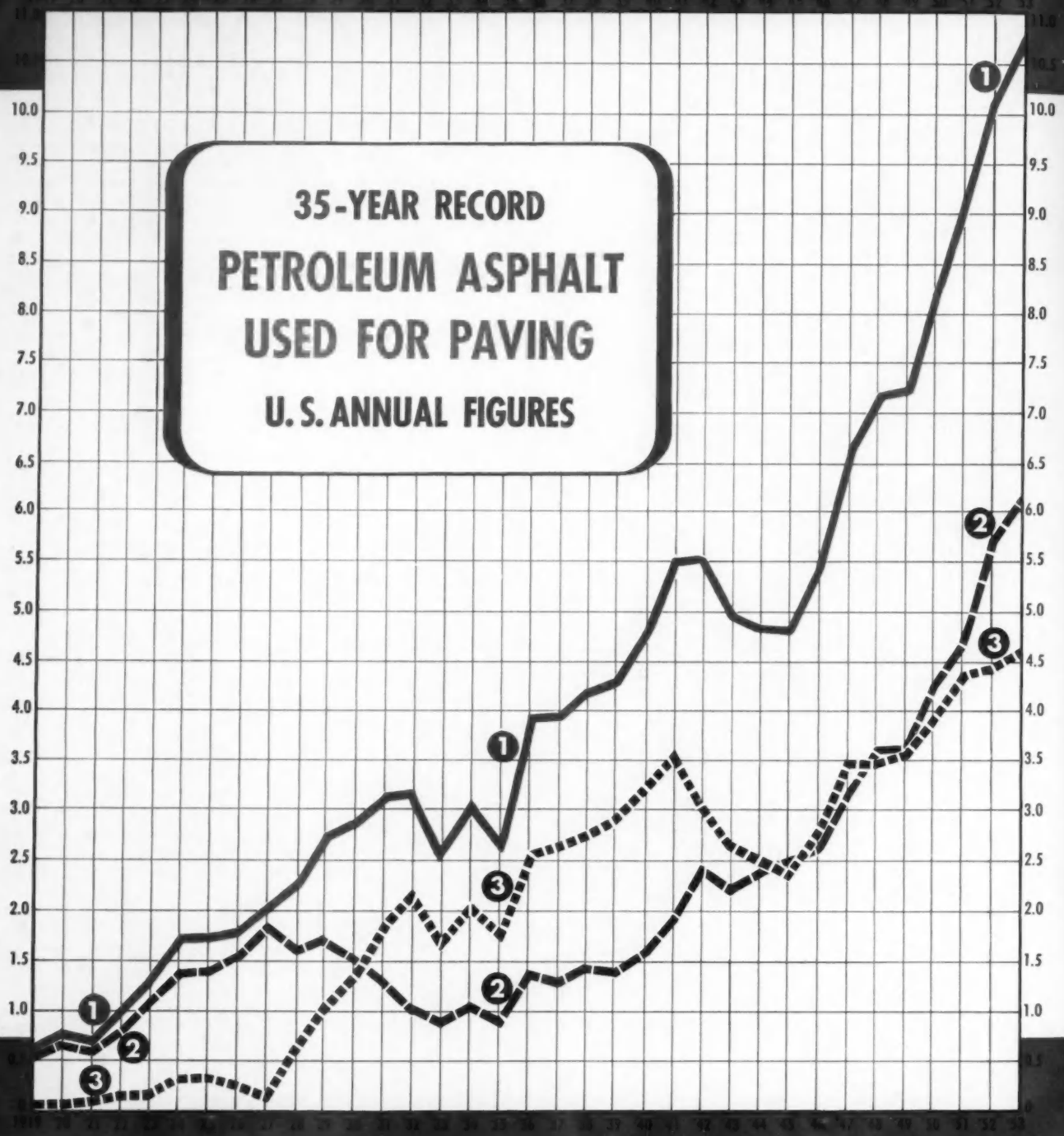
Asphalt Institute Quarterly

APRIL 1954





KEY

1. TOTAL FOR PAVING (ALL GRADES) (2+3)
2. PAVING CEMENT AND FLUX
3. LIQUID GRADES (EXCEPT FLUX)

SOURCE: U. S. BUREAU OF MINES ANNUAL FIGURES
1953 ESTIMATED
CHARTED BY THE ASPHALT INSTITUTE APRIL 1954

ASPHALT INSTITUTE Quarterly

VOL. 6, No. 2 APRIL 1954

The Asphalt Institute Quarterly is published by the Asphalt Institute, a national, non-profit organization sponsored by members of the industry for the purpose of promoting interest in the use of asphaltic products.

The names of the Member Companies of the Institute, who have made possible the publication of this magazine, are listed herein on page 15.

EDITORS

Bernard E. Gray, *President of The Asphalt Institute*
Ernest M. Bristol, *Director of Public Relations*

CONTENTS

Chart—Petroleum Asphalt Used for Paving 35-Year Record . . . . . Page 2

Highways—Highway Costs—Highway Safety . . Page 4

Liquid Asphaltic Materials *Third in the Research Series* . . . . . Page 11

Asphalt Institute Engineers . . . . . Page 14

Addresses of District Offices . . . . . Page 14

Members of the Asphalt Institute . . . . . Page 15

Articles may be freely reprinted with credit line. Correspondence should be addressed to the Asphalt Institute Quarterly, 801 Second Avenue, New York 17, New York.

COVERS

The double covers picture shows a section of the famed asphalt-paved New Jersey Turnpike. Its 1953 safety record of 4.14 fatalities per 100,000,000 vehicle miles, as against the National Average of 7.0, together with its great volume of traffic (22,000,000 vehicles in 1953), make it the most heavily traveled and one of the safest heavy-duty highways in the world.

Photo: Ostergaard

This chart illustrates the remarkably steady growth in the use of petroleum asphalt for paving during the past thirty-five years. How rapidly the asphalt industry has used this tonnage in successful competition for highway mileage appears in the charts herein on page 7.

EDITORIAL

Catastrophe—these seem to be days when no subject may be discussed except in terms of impending calamity. It makes no difference, apparently, whether it is some aspect of the international situation or merely a local matter. Alarmists are saying that the road system of the United States is practically worn out and that in 1956 or 1965, or some other time soon, it is doomed to collapse. So-called survivor curves apparently prove that our highways will wear out in some such period as seven or ten or fifteen years and, unless something miraculous is done about them at once, that traffic will come to a standstill. Isn't this just a little inconsistent with the prediction, often made by the same people, that notwithstanding the 55,000,000 cars and trucks running about in 1954, there will be 80,000,000 in use in 1980? Might not one ask just how these "worn-out and gone" highways are to carry this huge volume of motor vehicles some twenty-five years hence, if the roads will have disappeared before then?

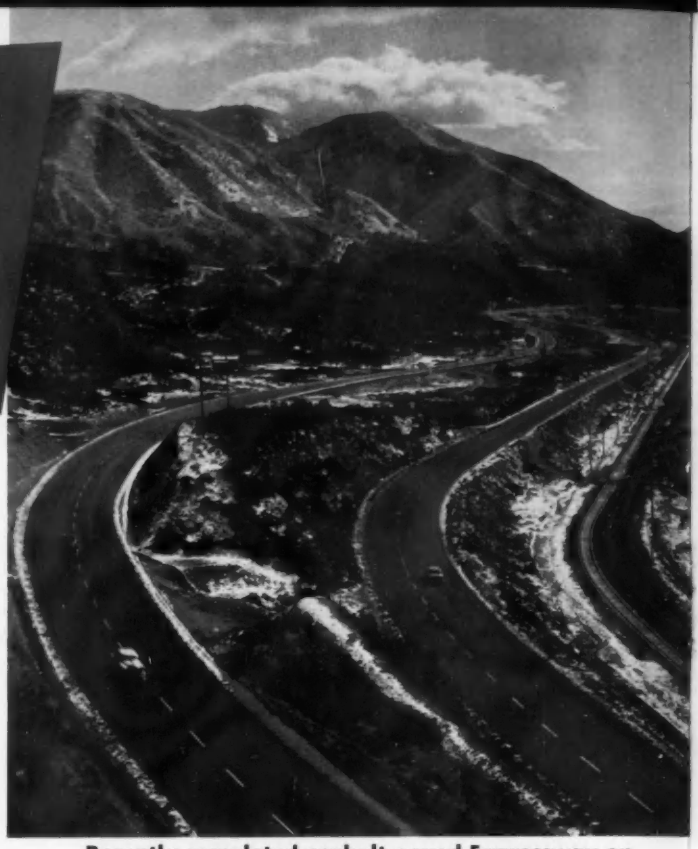
The answer of course is simple. The needs will be met, just as in the past, by continued *stage construction* to meet new conditions as they develop. Actually there has been more catching up on the deficiencies of war years than most people suppose. Long before present highways might reach a point of non-use, they will have been reconditioned or replaced with wider, stronger and better ones, provided common sense methods of salvage are continued. This is a process now going on in varying degrees in every State. Quietly and without fanfare, the highway engineer is steadily improving the system, often by maintenance procedures, so that each year's roads are better than the year before. A little reflection shows that this must be the case. Does any motorist of long experience really believe that he traversed the open country better in 1920 than he did in 1940, or in that later year more comfortably than in 1950? Of course not, and he has every reason to expect to travel more easily in 1960 than he does today.

It is too frequently stated that because the present dollar has lower purchasing power than in past decades, the current larger appropriations actually buy no more than the smaller ones of former years. This is not generally true. While labor costs are higher and larger-size equipment costs more, improved techniques are producing unit costs but slightly higher than they were twenty and thirty years ago. The real question is—how are these increased funds being spent? Are expressways always the answer? Are secondary roads being improved beyond real needs because of too rigid standards, thereby taking funds that could be utilized elsewhere to better advantage? Are existing roads always salvaged as completely as possible, thereby avoiding costs for expensive new right-of-way and loss of bridges and roadbeds already in place? Are new pavements constructed at the lowest cost consistent with durability, serviceability, and utility?

Current funds annually available for highways are nearly six billion dollars. They will automatically increase with the further increase in number of motor vehicles. Wisely used, such huge sums should produce the highway facilities required in a surprisingly few years. With so much construction ahead, the competition between paving materials has become increasingly sharp. This issue of the Quarterly therefore is devoted largely to comment on this timely phase of the matter.

HIGHWAYS- HIGHWAY COSTS- HIGHWAY SAFETY

By Bernard E. Gray



Recently completed asphalt-paved Expressway on U. S. Route 91 near San Bernardino, California.
Photo: *California Highways and Public Works*

INTRODUCTION

Passage of the largest Federal Aid Highway Bill in history, amounting to nearly $2,000,000,000 for the fiscal years 1956-1957, has focused attention upon the program for continued expansion of street and highway facilities. It explains the recent appearance of many articles and advertisements dealing with the subject of highway safety and highway costs. This literature, advanced in the hope of inducing public demand for a particular product, anticipates the intensive competition expected in the years ahead for the billions of dollars to be expended in construction and maintenance operations.

Competition is the life of trade, a trite but recognized truism. Competition is also a basic characteristic of the free enterprise system, and it has led to such improvements in equipment and materials that work can be accomplished today not only better and more rapidly, but often at lower costs than ever before. To be completely beneficial to the public, however, all factors which bear upon a situation must be fully presented and continually reappraised in the light of changing conditions. Some of these factors will be discussed here.

* * * *

FUNDS AVAILABLE

Highways today are big business, very big business. They have always been important, of course, but today adequately improved roads and streets are vital to the welfare of every individual. Without them, city-dwellers would be on starvation rations within a week. Except on a very few farms, plowing, seeding and harvesting would come quickly to a stop for lack of motive power. Few people realize the amounts now involved in highway operations nor the sharp increases since the end of World War II. The statistics are illuminating:

Total Highway Expenditures
Federal — State — Local — City
Source: U. S. Bureau of Public Roads

Year	Annual Totals
1925	$ 649,125,000.
1930	2,499,000,000.
1935	1,746,000,000.
1940	2,341,000,000.
1945	1,432,000,000.
1950	4,150,000,000.
1952	*5,014,000,000.

* Preliminary

Note particularly the very large gain in the years since the end of World War II, reflecting the extraordinary expansion in use of motor vehicles. The Bureau of Public Roads' bulletin, just released, entitled "Highway Finance, 1945-1952," is most informative. The quotation below presents an excellent picture of the current situation:

> "Estimated *receipts* of all governmental units for highway purposes in 1952 *approach the $6 billion level*, amounting to $5,725 million, including $1,038 million of new borrowings. The latter figure represents a new high in the use of credit financing. The total of $5,725 million exceeds the 1951 estimate by $702 million, or 14 percent.
>
> "*Total receipts have almost tripled over the 8-year period from 1945 through 1952*—from a total of $1,933 million in 1945 to $5,725 million in 1952. The major portion of this increase comes from State highway-user imposts and borrowings, although the contributions from other sources have also increased materially.
>
> "The $2,771 million derived from State highway user imposts in 1952 represents an increase of 11.5 percent over the corresponding 1951 figure. 1952 toll receipts show an increase of almost 33 percent over 1951. Property taxes and miscellaneous revenues both show slight increases in 1952.
>
> "The estimated total highway debt outstanding at the end of 1952 was $5,798 million, an increase of more than $2 billion over 1945, and $681 million greater than in 1951. Of this 1952 total, approximately $1.8 billion are toll-revenue bonds. Although the highway debt outstanding is rising at a very rapid rate, approximately $1.5 billion of

this debt does not entail the full faith and credit of the States or local units, and the debt for which they are actually responsible is $200 million less than their 1952 revenue (less tolls) for highway purposes. Thus, the debt outstanding to which payment the full faith and credit of the governmental units is pledged is still relatively low.

"Principal payments have increased considerably over the 8-year period, and the increased interest payments have already been noted. Although annual debt-service requirements are substantial, it is worthy of note that in 1952 such charges constitute only 10.9 percent of the total revenue for highway purposes, while in 1945 the corresponding percentage was 21.3."

required? The approximately 40,000 miles of the so-called Interstate System may or may not be the right number. It is quite likely that the potential 12,000 miles of toll roads may rather largely meet pressing needs in this regard and possibly will be completed before public funds become available for free roads on the same general locations. There will be, on the other hand, many areas where the wise development will be to disperse traffic over a number of parallel routes, improved to excellent two-lane standards, rather than to expend funds largely on a single route of four lanes or more in width. Not only is such improvement much lower in cost, but greater protection is afforded in event of war emergency, as well as in everyday travel.

Continued on page 6

TABLE I

SUMMARY OF RECEIPTS FOR HIGHWAYS AND STREETS

Source	1945	1946	1947	1948	1949	1950	1951	1952
				IN MILLIONS OF DOLLARS				
Summary:								
Federal funds	83	171	325	405	491	471	468	535
Highway-user imposts	1,098	1,463	1,609	1,825	2,095	2,289	2,510	2,804
Toll receipts	62	84	88	97	108	115	143	190
Property taxes and general revenues	581	718	728	892	942	946	1,003	1,046
Miscellaneous	47	52	62	71	91	107	108	112
Grand total revenues	1,871	2,488	2,812	3,290	3,727	3,928	4,232	4,687
Bond issue proceeds	62	174	308	476	531	656	791	1,038
Grand total receipts	1,933	2,662	3,120	3,766	4,258	4,584	5,023	5,725

Source: U. S. Bureau of Public Roads

The long lines of passenger vehicles on Woodhaven Boulevard in Borough of Queens, New York City, and the heavy truck congestion on midtown Manhattan's narrow 35th Street, cite the need for better traffic handling in urban areas.
Photos: *Ewing Galloway*

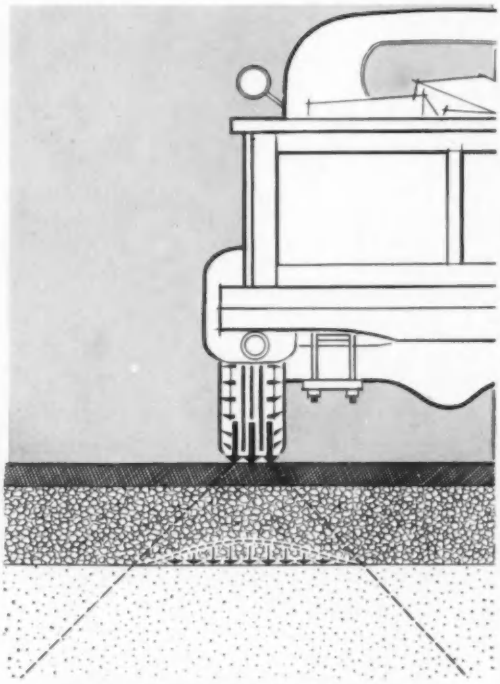
Several items in Table 1 are significant. First, highway user imposts have nearly tripled within an eight year period. These reflect directly the great increase in registration fees and gasoline taxes. Further large increases are to be expected. Second, the item for toll receipts also has nearly tripled. It is expected that this method of financing work will be much further extended. Recent careful estimates indicate a possible 12,000 miles of highways to be so provided, costing over ten billion dollars. Third, there is even a doubling of revenue from property taxes and appropriations from general funds since 1945. Taking all these sources into account, it may well be that the annual highway bill within a few years will reach the eight billion dollar level.

LONG RANGE PLANNING

Now what is to be done with these sums, amounts not even dreamed of but a few years ago? Unless there is to be waste, the most careful planning is required, and not piecemeal planning either. There is need to survey the transportation situation as a whole, and this means eventual full correlation of highway operation with the railroads and the air lines. It also means better handling of traffic within congested areas where streets are too narrow to allow the free flow of thousands of large passenger vehicles and trucks. Cities, with only some 350,000 miles of streets, now carry nearly 50% of all traffic; while the rural highways, some 3,000,000 miles in length, carry the other half. To solve this congestion problem, it is conceivable that in some metropolitan areas parking at peripheral boundaries will eventually be required, followed by passenger and freight transfer to some form of public transportation which can move quickly and cheaply in all directions once the streets are cleared.

Then there is the broad question of the place of expressways outside of cities. How many miles are really

When supporting foundation gives way beneath rigid pavement beam, the slab often cracks, as shown, under applied loads.



Flexible pavement surface is always in contact with foundation, with imposed loads distributed throughout entire structure.

SELECTION OF PAVEMENT

Finally there is the question of the pavement itself. Is the present pavement adequate or should it be replaced? If a new one is to be constructed, what type of pavement is the best to lay? For over thirty years a rather continuous process has been the improvement of highway locations in respect to alignment and grade. This will, of course, continue on the rather limited mileage of heavy-duty highways, but on the larger portion of rural roads the ultimate location is rapidly becoming fixed, except for very minor changes. Their economic further improvement will certainly consist of widening and resurfacing existing roadbeds, thus utilizing all the present pavement values as foundations for the new surface.

On the new locations there is opportunity to construct quality subgrades from locally available soils and aggregates which can provide foundations of permanent strength and which, if not fully utilized, would be a tragic waste of recent engineering research. Where proper controls are exercised, the selected soil subgrades will develop foundation values equal to substantial thicknesses of pavement, at costs which are not much greater than for ordinary excavation. This fact was fully proven in the construction of the Turner Turnpike in Oklahoma, after thorough study of the bids for selected soils as compared with unclassified excavation.

Why, then, is not this type of foundation employed exclusively in road-building? The reason is that the most advantageous use of such low-cost improved subgrades is made by laying but one kind of pavement, the flexible type, thus giving it a competitive advantage. To understand why this is so, a description of the two principal types of construction may be helpful, particularly as many thousands of readers of this magazine are not engineers and possibly are often at a loss to understand what the controversy over paving is about.

PAVEMENTS—RIGID AND FLEXIBLE

There are two principal types of pavements, the difference between them being the way in which they support a load. One kind of pavement is called the rigid type, the other, the flexible type. The rigid type behaves like a beam. If the subgrade settles beneath it the beam must bridge the depression and, if not thick enough to do so, it will, of course, break. Continued application of load at the broken place then may cause pumping or additional breaking at some point several feet away, and so the deterioration continues.

In contrast, the flexible pavement is always in contact with the foundation beneath, so that not only the surfacing layer resists imposed loads but also the base courses and subgrade. By making the foundation strong enough to absorb the loading transmitted through the surfacing, no surface breaking can occur.

Although it is agreed that either pavement type—flexible or rigid—can be built to support any load, the matter of which costs the most leads to further considerations. For any given highway load it is *always possible to obtain the necessary strength with less thickness of the flexible surface course than of the rigid type.* This leads almost invariably to a lower first cost for the entire flexible pavement structure than for the rigid design. Where soil conditions are particularly favorable, it is actually possible to build, for the same cost, three miles of flexible pavement as against one mile of a rigid type which is to carry the same load; in other situations the saving in favor of the former may be twenty to thirty percent. All-weather flexible pavements are called bituminous pavements because the surfacing layer is bound together with bituminous material. Asphalt is the principal bituminous binder employed in the modern construction of highways.

As might be expected, with such a substantial first-cost advantage for asphalt construction, controversy has developed around other properties of pavements, principally in respect to maintenance cost and safety. These will be discussed later in this article, for it is, of course, true that the items of durability, as represented by the maintenance cost, and satisfactory use, as perhaps indicated by the safety records, are very important factors.

MILEAGE OF PAVEMENTS IN PRESENT USE

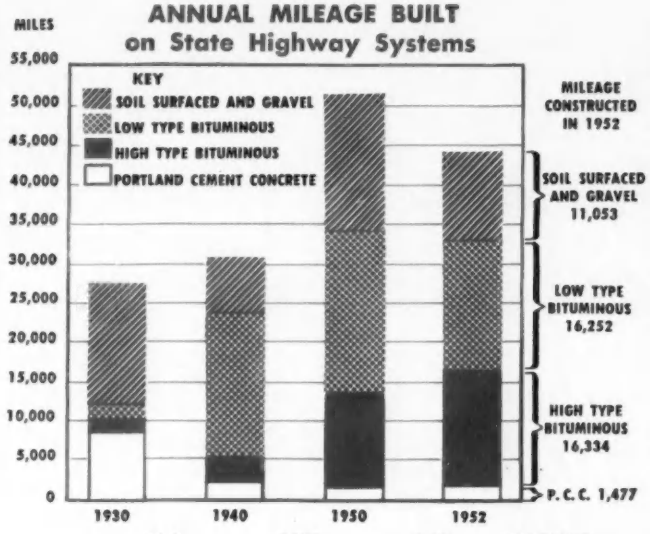
As the old proverb goes, "the proof of the pudding is in the eating," and so proof of the merit of various highway surfacings is to be found in their comparative mileages. It will be seen very quickly that without asphalt there would be no modern highway system. It is not necessary for one to read statistics to know that such is the case. The next time you take a trip by plane just look out the window and see to what extent asphalt covers our roads, highways and city streets. Also notice the lesser mileage of rigid pavement and see how much of it has dark transverse and longitudinal markings together with irregularly shaped areas of the same color. All these markings are either joints filled with asphalt, or asphalt patches. Asphalt is the work-horse material of the highway industry; without it, traffic would come almost to a standstill.

Charts I and II show the growth of improved mileage over the years on State Systems in the United States. An interesting fact illustrated in Chart II is that, by the important step-by-step procedures of stage construction, the Soil Surfaced and Gravel and Low Type Bituminous mileages gravitate progressively into heavier-duty roads, sometimes finding their way to the High Type Bituminous category. The Portland Cement Concrete mileage also is going increasingly into the High Type Bituminous category through modernization by asphalt resurfacing. This latter process, in fact, has been proceeding so rapidly that there are actually fewer miles of unsurfaced rigid pavement on the State Highway System today than in 1940.

Now all this didn't just happen to take place. It is the result of the considered judgment of thousands of engineers who, after evaluation of all the factors involved, decided to employ a flexible design.

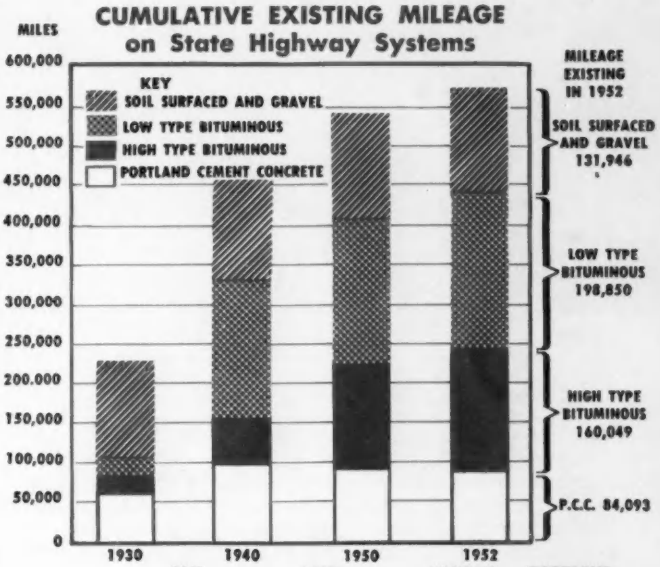
Continued on page 8

CHART I
ANNUAL MILEAGE BUILT on State Highway Systems



YEAR	SOIL SURFACED AND GRAVEL	LOW TYPE BITUMINOUS	HIGH TYPE BITUMINOUS	PORTLAND CEMENT CONCRETE
1930	15,306	1,371	1,973	8,814
1940	7,133	17,934	3,335	1,985
1950	17,564	20,303	12,876	1,380
1952	11,053	16,252	16,334	1,477

CHART II
CUMULATIVE EXISTING MILEAGE on State Highway Systems



YEAR	SOIL SURFACED AND GRAVEL	LOW TYPE BITUMINOUS	HIGH TYPE BITUMINOUS	PORTLAND CEMENT CONCRETE
1930	122,430	20,229	22,661	58,208
1940	137,927	157,580	51,460	94,534
1950	132,878	182,738	134,697	89,311
1952	131,946	198,850	160,049	84,093

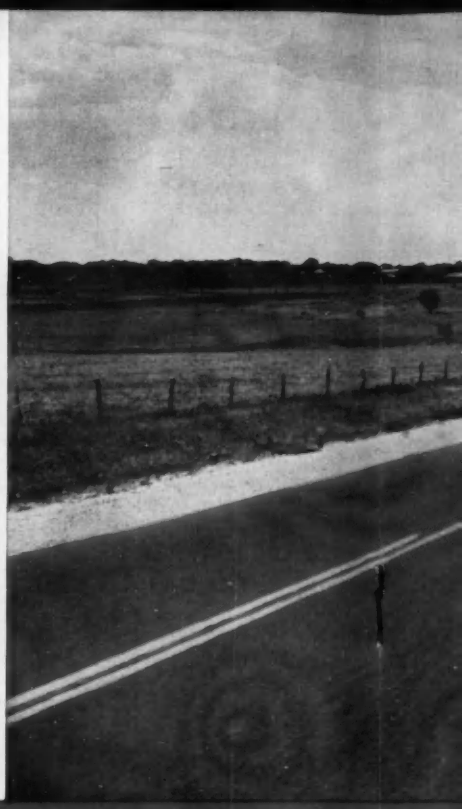
NOTE: These charts relate *only* to mileage on State Highway Systems. The 1952 figures for the *entire* existing improved Rural Mileage, as shown by the U. S. Bureau of Public Roads in its latest annual report, are as follows:

Soil Surfaced and Gravel	1,137,592 Miles
Low Type Bituminous	376,490 "
High Type Bituminous	182,702 "
Portland Cement Concrete	85,691 "

This indicates over a million miles to be improved to pave*ment* types and, as between these latter, a present lead for Bituminous Types over Portland Cement Concrete of 87% to 13%.

SOURCE: U. S. BUREAU OF PUBLIC ROADS FIGURES

Along Massachusetts' Cape Cod Canal runs U. S. Route 6, asphalt-paved. Latest compiled maintenance costs for this State, as included in Oklahoma's Bailey Report, show an average per mile per year of $117.73 for asphalt against $184.77 for portland cement concrete.



This asphalt highway, U. S. [illegible] near Austin. For Texas, Baile[illegible] cost per mile per year of $[illegible] portland cement concrete.

MAINTENANCE COSTS

Maintenance costs are among the most controversial items in the whole competitive picture. Records in many states are unavailable insofar as separation of pavement costs from other costs is concerned. Massachusetts, however, has one of the longest annual maintenance compilations. In this state there are large mileages of both rigid and flexible pavements and, although extreme conditions of climate prevail, with traffic for the most part intensely concentrated, the per mile per year figures have been remarkably low. In fact, for a standard pavement 24 feet wide the per mile average annual surface maintenance costs over a 20-year period, were only $118.97 for the flexible asphalt and $150.65 for the rigid concrete.

Following a thorough maintenance study by The Oklahoma Turnpike Authority preliminary to taking alternate bids on rigid and flexible type pavements, complete figures for 17 states were made available in its Bailey Report. Texas, for example, reported that high-type asphalt laid on a good base cost less to maintain than portland cement concrete. New Hampshire showed, for the year 1949, maintenance costs favorable to asphalt by $61.72 to $133.68. The per mile per year costs for California were $158.00 for asphalt against $261.00 for portland cement concrete. Maine reported annual maintenance costs of $145.38 against $219.45, in favor of high type asphalt.

In Kansas, a weighted average of maintenance costs, derived from a study covering the years 1946, 1948, and 1949, showed that high type asphalt highways in this state cost $397.58 for annual maintenance per mile, with portland cement concrete costing $607.11 per mile.

In ten states where maintenance figures submitted were directly comparable, the cost for maintaining high type asphalt was lower than for portland cement concrete, with the overall average of $217.00 against $244.00 per mile.

In the annual cost of a highway there are included the amortized first cost plus the cost of maintenance. Just what this means, when any substantial saving in first cost is secured, is well represented by Oklahoma's Turner Turnpike. Here the combined low bids for asphalt pavements were $1,161,120 lower than the best bids on concrete (rigid type). As this project is 88 miles long, the saving per mile (in round figures) was $13,200. Invested in Turnpike bonds at 3½% there would be thus available for maintenance (out of first cost savings alone) $462.00 per mile per year, which in itself is sufficient to provide the normal surface maintenance required.

While the maintenance costs on asphalt are frequently lower than for concrete, both types properly built require about the same annual expenditures per square yard. It follows then, that *the true difference* in cost between asphalt and concrete on this project is the first cost saving of $1,161,120 plus the interest thereon ($1,625,570) over the life of the bonds (40 years), a total of over $2,785,000. If this difference were figured (without the amortization factor), the initial asphalt saving of $1,161,120 could earn interest at 3½%, compounded semi-annually, for 40 years, and the margin of economy, as compared with the rigid pavement bid, would amount to over $4,500,000.

hway, U. S. Route 81, cuts through Texas countryside
Texas, Bailey Report shows an average maintenance
r year of $106.72 for asphalt against $153.76 for
concrete. *Photos: Ewing Galloway*

MAINTENANCE COMPILATION METHODS

In maintenance statistics, the general practice today is to record a rigid pavement as an asphalt road whenever it is covered with 1½ inches or more of asphalt. Accordingly, over the years all of the poorest rigid types, resurfaced with asphalt out of necessity, have been eliminated from the rigid pavement statistics, while the asphalt column often has been burdened with them. In other words, only the maintenance costs on the *best* rigid roads continue to be reported, while not only all asphalt roads but also most resurfaced rigid roads are reported as asphalt mileage. Notwithstanding this handicap, the trend is toward lower maintenance costs on the heavy-duty asphalt pavements.

Close study of all maintenance figures available reveals that variations in cost are related not only to type of surface but also to width. While any pavement only 18 feet wide is severely punished under heavy traffic, the same type 24 feet in width requires but nominal repair. Taking all factors into account—age, design and traffic—it is the considered judgment of most unbiased observers that *properly constructed pavements of either type have about the same maintenance costs.* When new, a 24-foot pavement should not exceed ½ cent per square yard per year ($75 per mile) and, when much older, 2 cents per square yard maximum ($300 per mile). With the first-cost savings for flexible-type pavements running from $1.00 per square yard and up, the usual occurrence, the saving on interest alone is more than sufficient to pay the entire cost of maintenance. The annual cost of asphalt pavements is therefore lower, as a general rule, than any other type.

Both rigid and flexible pavements may be constructed which will last for many years and will substantially maintain their original condition. There are asphalt roads throughout this country which are still in existence after 40 or 50 years of service. No pavement of any kind, however, can be built to retain its *original* smoothness for such a period. The joints in a rigid pavement will separate or settle in some degree. An asphalt pavement will wear more at some places than at others.

DESIRABLE PROCEDURE

The desirable and sensible procedure will be to carry on maintenance in such a way that high-quality smoothness can be restored periodically at low cost. This is economically possible only with asphalt surfaces. By means of heater-planers, for example, such surfaces can be heated and scraped to exact smoothness just as a wooden board is planed. Engineers can then place a thin new asphalt layer which will be so thoroughly bonded to the original surface that it becomes an integral part of it. Such procedure, at intervals of fifteen years or so, will extend the useful life of flexible types indefinitely. It can be confidently expected that, where the new roadbeds of selected soils and bases have been installed, a life of even a hundred years will become routine.

SAFETY

Everyone talks about safety. Unfortunately, too little is done about the real cause of highway accidents. It is a positive disservice to better understanding of the problem to imply that a particular pavement will provide safety and that if all roads were covered with such a surface, accidents would be reduced. Nothing could be further from the truth. Every operator of a motor vehicle should read these few paragraphs from the 1954 accident study of The Travelers Insurance Companies:

> "Our annual studies of highway accidents have shown that more than ninety percent of the vehicles involved were in good condition: the highways were adequate if used at the speeds for which they were designed. We found the weather to be a negligible factor. We found that curved roads were no more hazardous than straight ones. Over the whole span of the passing scene, we have found that these were variables in the equation of highway safety. The constant, unchanging factor was the man, woman, or child who sat behind the wheel of a car and transformed it from a useful servant to a projectile of destruction; or who, as a pedestrian, walked carelessly into the path of danger.
>
> "We are not psychologists. We cannot attempt to analyze the motives or impulses by which rational human beings become automotive killers. We know that some of these are too complex for the layman to understand. But some are so obvious that they sound a steady theme throughout our statistical surveys. Excessive speed is a killer, so is driving while intoxicated, weary or ill. Violation of the rules of the road is a prelude to disaster, so are gross carelessness and the willful abuse of highway etiquette. Although it is not our function to analyze or moralize more deeply, the conclusion is obvious. *In most accidents, the guilty party is man and not machine, mind and not motor, reflex and not roadway.*"

Continued on page 10

TABLE II

FATALITIES PER 100,000,000 VEHICLE MILES				
TURNPIKE	TYPE	CLASSIFICATION	1952	1953
PENNSYLVANIA TURNPIKE	PORTLAND CEMENT CONCRETE	RIGID	7.30	7.50
*NEW JERSEY TURNPIKE	ASPHALT	FLEXIBLE	6.10	4.14
**MAINE TURNPIKE	ASPHALT	FLEXIBLE	3.59	1.13
***OKLAHOMA TURNPIKE	ASPHALT	FLEXIBLE		3.84
NATIONAL AVERAGE	ALL TYPES		7.30	7.00

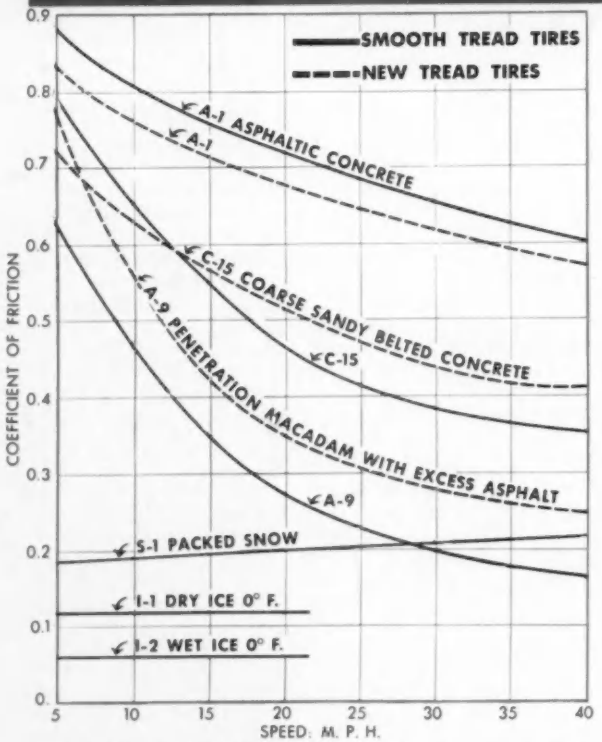
*First Quarter 1954: 2.83
**Six Year Average 1948 to 1953, inclusive: 2.54
***Opened to Traffic: May 16, 1953

The real answer to the problem is better education of the driver and strict enforcement of the law. A most striking contrast in this regard is the accident record on two Turnpikes, the New Jersey and the Pennsylvania. The New Jersey Turnpike (asphalt-paved) carries the greater volume of traffic, yet its fatality record is much more favorable than that of the Pennsylvania Turnpike with its rigid type pavement. The Maine Turnpike (asphalt-paved) also has a remarkable record, as does the Turner Turnpike in Oklahoma. These three most widely separated asphalt turnpikes are representative of varying traffic and climatic conditions, yet they are among the very safest in the United States. This is shown in Table II herewith, which was compiled from a study by the Keystone Automobile Club, statistics of Turnpike Authorities, and the Automotive Safety Foundation. City streets, too, are largely paved with asphalt. Half of all traffic is within city limits, yet here also the accident rate, despite most intensive concentration, is much lower than the national average.

CHART III

SKIDDING CHARACTERISTICS OF ROAD SURFACES

The higher the coefficient of friction the greater the resistance to skidding.



Coefficients of friction for new tread and smooth tread passenger cars on various types of surfaces. All tests conducted on wet surfaces except as noted. Engineering Experiment Station, Iowa State College, Ames, Iowa

SKID RESISTANCE

Skidding is not a pleasant experience, but it is not the principal or even an important cause of accidents. Skidding cannot occur unless a car is initially out of control. It takes place when the frictional resistance between pavement and tire is exceeded. The tire companies in their advertising have done a good job of educating the public in respect to tire design. Some very complete studies also have been made on the anti-skid characteristics of pavements, one of the best-known having been conducted by Professor R. A. Moyer, and reported by the Highway Research Board. The results are well summed up in Chart III, which shows very clearly that high-type asphalt surfaces built to modern designs have about the highest frictional resistance possible.

CONCLUSIONS SUMMARIZED

1. **Highway funds are becoming rapidly available in amounts sufficient to bring transportation facilities into proper balance with traffic demands, provided sensible procedures are followed in respect to maximum use of existing roadbeds, and low-cost methods in new construction are employed.**
2. **The mileage of highways already constructed indicates very clearly that the flexible type (asphalt) has the lowest first cost, and also the lowest annual cost, because**
3. **Maintenance costs on either flexible or rigid pavements, properly constructed, are either favorable to asphalt or practically identical.**
4. **Safety on the highways is not a matter of surfacing, but one of proper traffic control, and any attempt to divert attention in this regard is a disservice to the public.**

LIQUID ASPHALTIC MATERIALS

By John M. Griffith
Engineer of Research

Third in the Series "Asphalt as a Material"

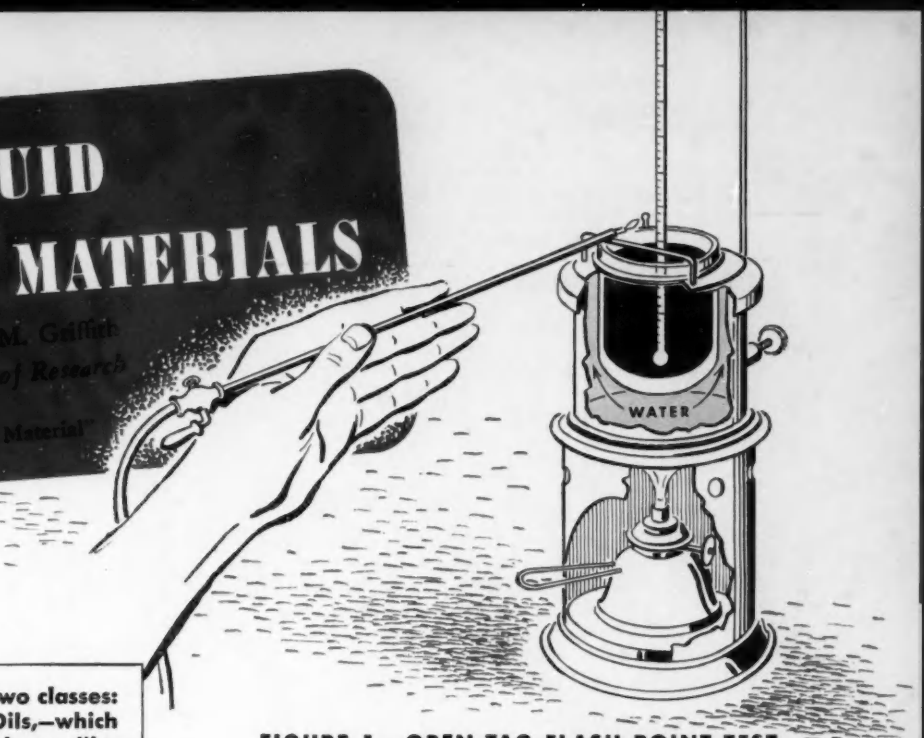


FIGURE 1 — OPEN TAG FLASH POINT TEST

Liquid Asphaltic Materials are of two classes: (1) Cutback Asphalts and Road Oils,—which contain various amounts of petroleum diluents; and (2) Emulsified Asphalts,—which are asphalts suspended in chemically-treated water. The former class will be discussed here, with a future article on Emulsified Asphalts.

For many applications it is desirable to employ asphaltic materials of a more liquid consistency than the asphalt cements discussed in the preceding article of this series.* The liquid asphaltic materials which are a blend of asphalt cement and volatile petroleum distillates, or diluents, are of three standard types: (1) Slow Curing, (2) Medium Curing, and (3) Rapid Curing. The Slow Curing products, often called "Road Oils," are usually a residual material resulting directly from the fractional distillation of certain crude petroleums. Lighter fractions of the crude stock (naphtha, gasoline, kerosene, certain oils, etc.) are first vaporized in the distillation tower and then drawn off for further separation. A residue of asphalt and oil remains, the consistency of which depends principally upon the amount and character of the oil. Slow Curing liquid asphaltic materials may also be prepared by blending an asphalt cement with an oily petroleum fraction.

Medium Curing and Rapid Curing liquid asphaltic materials, known as "Cutback Asphalts," are a blend of asphalt cement with naphtha, gasoline or kerosene. The asphalt cement is produced as described in the preceding article of this series and the desired diluent intimately mixed with it in a blending tower. Rapid Curing products are prepared with a light, rapidly-evaporating diluent such as a naphtha or gasoline, while medium curing products are prepared with a less volatile diluent such as kerosene.

GRADES

Each of these three types of liquid asphaltic materials is produced in six standard grades. The prefix (SC, MC, or RC) of each grade denotes the type—SC for Slow Curing, MC for Medium Curing, and RC for Rapid Curing. The suffix, or grade number, denotes the consistency range of the material:

SC-0	MC-0	RC-0
SC-1	MC-1	RC-1
SC-2	MC-2	RC-2
SC-3	MC-3	RC-3
SC-4	MC-4	RC-4
SC-5	MC-5	RC-5

In each type, Grade 0 is the most liquid, Grade 5 the most viscous, with the intermediate grades ranging in consistency in an orderly progression. At room temperatures, the consistency of Grade 0 materials is approximately that of heavy cream, while Grade 5 materials have approximately the consistency of heavy molasses in cold weather. Specifications for the various properties of these liquid asphaltic materials appear in "The Asphalt Handbook" and "Useful Tables," both published by The Asphalt Institute.

TESTS

For practical application of these materials, the user requires certain specific characteristics. These are measured by standard tests, with limiting values for each prescribed by specifications.

Flash Point. The *flash point test* is usually performed on all cutback asphalts and road oils, with appropriate limits included in most specifications. The significance of this test, as well as the details of the Cleveland Open Cup Flash Point Test used for SC products, were discussed in the preceding article of this series.

Because of the more volatile nature of the RC and MC types, however, the test for flash point on these materials requires a somewhat different type of heating cup. Equipment for this test, which employs indirect heating, is illustrated in Figure 1 and the procedure is fully prescribed by the American Association of State Highway Officials (AASHO) in Method T79.

Continued on page 12

* Preceding article: Asphalt Institute Quarterly, Vol. 5, No. 4, October, 1953. First article: Vol. 5, No. 2, April, 1953.

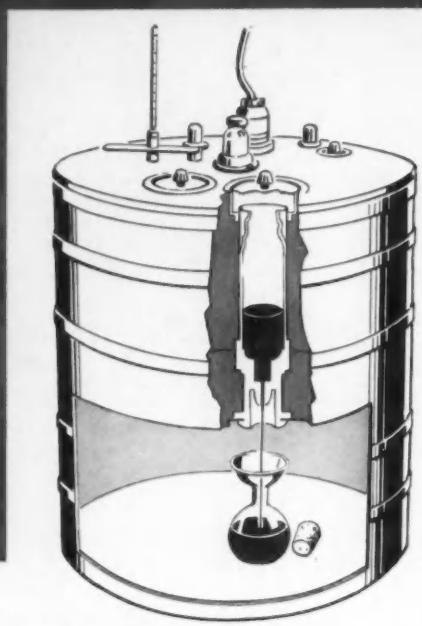


FIGURE 2 — VISCOSITY TEST

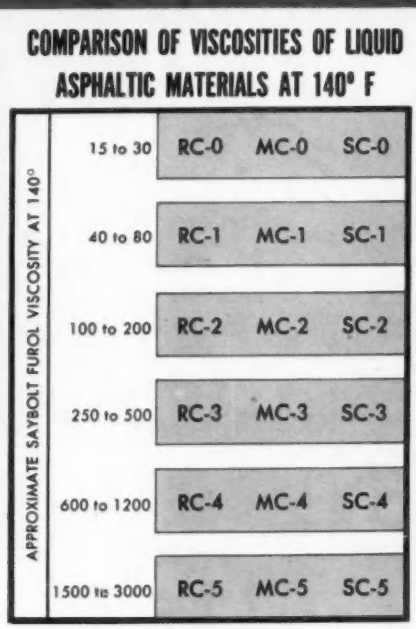


FIGURE 3

Viscosity. The consistency of cutback asphalts and road oils is measured by the *Saybolt Furol Viscosity Test.* The procedure and equipment needed for conducting this test have been standardized by The American Society for Testing Materials (ASTM) and are fully prescribed in ASTM Designation D88. A given volume of the material is heated in a standard "tube," in the bottom of which is an orifice of specified shape and dimensions. A stopper closes the orifice until the material reaches the prescribed test temperature. The stopper is then withdrawn, and the time in seconds required for 60 millilitres of the material to flow through the orifice is determined. Figure 2 illustrates the test procedure. It is apparent that the more viscous the material, the greater the length of time required for a given volume to flow through the orifice. Thus, increase in the viscosity "number" indicates increase in the viscosity of the material.

An examination of Asphalt Institute specifications will indicate that the viscosity test is run at different temperatures for the different grades of these products. This is necessary because of the relative "sensitivity" of the test as compared with the wide range of viscosity properties of the several grades. In other words, if a test temperature were selected which would give significant numbers for the more liquid grades, an extreme length of testing time would be required for the more viscous grades. Increasing the test temperature would impair the significance of the test for the more liquid grades. Thus it has been found most practical to vary the test temperature for the different grades. Note that viscosity ranges in the specifications are identical for corresponding grades of these three types of materials. For example, SC-1, MC-1, and RC-1 are all required to have a Saybolt Furol Viscosity of 75-150 seconds at 122°F., meaning that corresponding grades of the three types have comparable consistencies.

For a general concept of the viscosity relationships of the various grades of cutback asphalts and road oils, a comparison may be made at a given temperature. Figure 3 illustrates this comparison at a temperature of 140° F.

Distillation. Each of the three types of material (SC, MC and RC) is a combination of asphalt cement and a diluent. The properties and relative amounts of both constituents are important in the application and service behavior of the material. A "distillation" can be made to separate the two constituents to determine the relative proportions of each. In the Rapid and Medium Curing types, the characteristics of the diluent are of considerable importance to the paving engineer as they govern the rate of evaporation and thus the rate of "cure." It is necessary, therefore, to determine the amount of diluent driven off at several temperatures during the distillation process. These proportional quantities are limited by specifications.

In the *distillation test,* fully prescribed in ASTM Designation D402, and illustrated in Figure 4, a given quantity of material is placed in a distillation flask connected to a condenser. While the material is being heated slowly to the desired temperature some of the diluent may be vaporized. The vapor becomes a liquid again in the condenser tube and falls into a graduated glass cylinder. The relative proportions of diluent vaporized at various temperatures are thus determined. The test is continued until the temperature of the residue in the distillation flask reaches 680°F. The remainder is considered to be asphaltic residue.

Penetration. The *penetration test* measures the consistency of residue resulting from distillation of RC and MC types. The procedure for running this test and its significance were discussed in the preceding articles of this series.

It is to be noted that Asphalt Institute specifications require that the residue from RC types have a penetration of 80-120 while the MC types must have a penetration of residue of 120-300. Under most conditions, nearly all of the diluent evaporates from RC and MC types during their early service life. It may be expected, therefore, that the penetration determined by test on the residue will be approximately that reached in the early stages of service life. It is to be further expected, however, that a longer period of time will be required for the diluent to evaporate from an MC than from an RC material.

Float Test. The residue from distillation of SC liquid asphaltic materials is subjected to the *float test.* This is a modified viscosity test, usually performed only where the material is either too soft for the penetration test, too viscous at a desirable temperature or too small in quantity for the Saybolt Furol Viscosity test. Its significance, there-

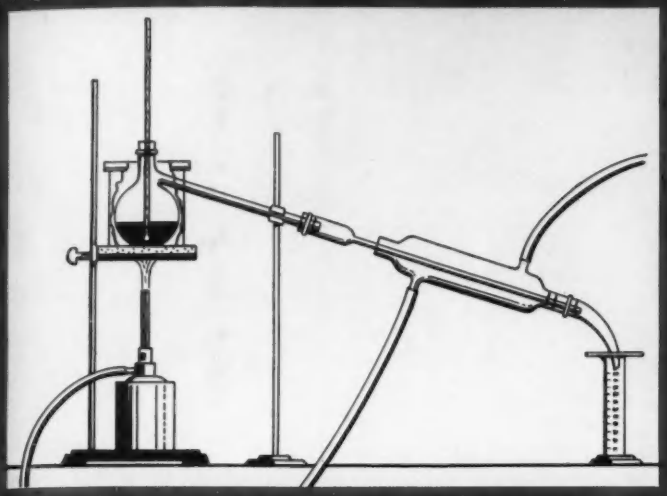


FIGURE 4 — DISTILLATION TEST

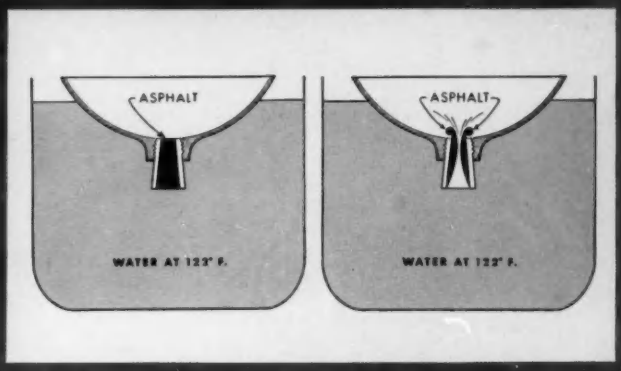


FIGURE 5 — FLOAT TEST

fore, is confined to an interpretation of consistencies of products within these limitations.

In the test, illustrated in Figure 5, a "plug" of asphaltic residue is solidified into the bottom orifice of the Float Cup by cooling to 41°F. The Float Cup is then placed in water at 122°F., and the time required for the water to break through the plug is determined. Values are limited by specifications for the various grades of SC liquid asphalt. The test is fully prescribed in ASTM Designation D139.

Solubility. Another test made on the residue from distillation of all SC, MC and RC asphaltic materials is one for *solubility*. This test and its significance are discussed in the preceding article of this series.

Asphalt Residue of 100 Penetration. This test, made only on SC products, is perhaps the least significant of all the common tests on these materials. Because the rate of curing of an SC material is slow, it may or may not reach a penetration of 100 during its service life. The principal value of the test is that it provides a residue upon which standard tests for asphalt cements may be run.

A sample of SC material is heated to a temperature of 480°-500°F. until it loses sufficient oils to reach a penetration of 100. The proportionate quantity, by weight, of asphaltic residue remaining is then determined. Specifications prescribe minimum proportions of such residue for each grade of SC liquid asphaltic material. The test procedure is fully outlined in ASTM Designation D243.

Ductility. The *ductility test* is made on the residue from distillation of RC and MC asphaltic materials. As the residue from distillation of SC products is usually too soft for a ductility test, the test is performed instead on the SC residue of 100 penetration as described. The significance and details of this test were discussed in the preceding article.

USES

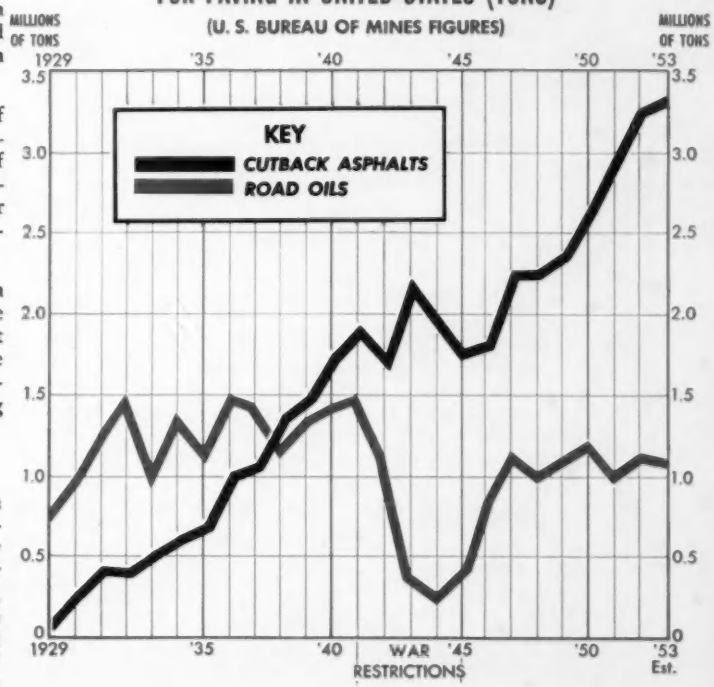
Cutback asphalts and road oils are widely employed in highway and airfield construction and in a variety of industrial applications, the more fluid SC grades frequently as dust palliatives on lightly traveled roads. These lighter grades of SC products, along with the lighter MC products, are most often used to prime existing road surfaces, while many grades of RC and MC products are frequently used for surface treatments with aggregate cover, the grade of material depending upon climatic and traffic conditions and type of aggregate cover. Many grades of all three types are employed in a variety of mixed-in-place and plant-mix pavement surfaces too numerous to mention here. The "Construction Specifications" of the Asphalt Institute provide specific instructions for employing these versatile paving materials, which have also been adapted by industrial engineers to fulfill a host of special functions peculiar to particular conditions of climate and use.

TONNAGE GROWTH

The increasing use of these cutback asphaltic materials and road oils is reflected in the twenty-five year tonnage chart below.

25 YEAR GROWTH OF CUTBACK ASPHALTS AND ROAD OILS FOR PAVING IN UNITED STATES (TONS)

(U. S. BUREAU OF MINES FIGURES)



ASPHALT INSTITUTE ENGINEERS

ROBERT B. McKEAGNEY
District Engineer at Boston

Robert B. McKeagney, with office at 585 Boylston Street in Boston, serves the Asphalt Institute as District Engineer throughout the New England territory, comprising the states of Maine, New Hampshire, Vermont, Massachusetts, Rhode Island and Connecticut.

Prior to joining the Institute, Mr. McKeagney, after graduating from the University of New Hampshire in 1942 with a Bachelor of Science Degree in Geology, served with the U. S. Army successively in the Boston District, the Norfolk District and the East Ocean Division. At the Boston office until 1945, he assisted in the evaluation of the Airfield program and, as field geologist, in the location of proper materials needed for construction. At Norfolk from 1945 to 1951, he served as Chief of the Geology and Foundation Unit.

Mr. McKeagney's association memberships include the Highway Research Board, the Association of Asphalt Paving Technologists, the Society of American Military Engineers, the American Institute of Mining and Metallurgical Engineers, and the Geological Society of America.

DILLARD D. WOODSON
District Engineer at Atlanta

Dillard D. Woodson, from the Asphalt Institute office in the Mortgage Guarantee Building, Atlanta, Georgia, serves as District Engineer throughout the states of Alabama, Florida, Georgia, South Carolina and Tennessee.

Mr. Woodson's engineering career includes long service in the highway building and maintenance field. In 1938 he was appointed supervisor of the newly organized soil section of the Virginia Department of Highways.

Enlisting in the Army in 1942, Mr. Woodson, holding the commission of Second Lieutenant, was assigned to instruct officers in all phases of airfield and road construction at Richmond Army Air Base, Richmond, Virginia; March Field, California; and Geiger Field, Washington. Upon separation from the service in 1946, he returned to the Virginia Department of Highways and his pre-war duties. In 1951 he was promoted to be Assistant Testing Engineer, leaving this post to accept his present position with the Asphalt Institute. He holds memberships in the American Society for Testing Materials and the Highway Research Board.

ENGINEERING OFFICES AND DISTRICTS

Mills Building—Washington 6, D. C.
Delaware, District of Columbia, Maryland, Pennsylvania

801 Second Ave—New York 17, N. Y.
New York City, Long Island and New Jersey

45 North Lake Avenue—Albany 3, New York
New York State (except New York City and Long Island)

585 Boylston Street—Boston 16, Massachusetts
Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont

5812 West Club Lane—Richmond 26, Virginia
North Carolina, Virginia

Mortgage Guarantee Building—Atlanta 3, Georgia
Alabama, Florida, Georgia, South Carolina, Tennessee

1531 Henry Clay Avenue—New Orleans 18, Louisiana
Louisiana, Mississippi

8 East Long Street—Columbus 15, Ohio
Indiana, Kentucky, Michigan, Ohio, West Virginia

Leland Office Building—Springfield, Illinois
Arkansas, Illinois, Missouri, Wisconsin

Midway Building—St. Paul 4W, Minnesota
Iowa, Minnesota, North Dakota, South Dakota

1250 Stout Street—Denver 4, Colorado
Colorado, Idaho, Kansas, Montana, Nebraska, Utah, Wyoming

Fidelity Union Life Building—Dallas 1, Texas
New Mexico, Oklahoma, Texas

Littlefield Building—Austin 15, Texas
Texas

Republic Building—Oklahoma City 2, Oklahoma
Oklahoma

Russ Building—San Francisco 4, California
California, Arizona, Nevada, Oregon, Washington

Pacific Mutual Building—Los Angeles 14, California
Southern California, Arizona

White-Henry-Stuart Building—Seattle 1, Washington
Oregon, Washington

Forum Building—Sacramento 14, California
Central California, Northern California, Nevada

The Asphalt Institute Quarterly is presented through the courtesy of the Companies listed herewith comprising the membership of the Asphalt Institute.

MEMBERS OF THE ASPHALT INSTITUTE

ALLIED MATERIALS CORP.
Oklahoma City, Oklahoma

AMERICAN BITUMULS & ASPHALT COMPANY
San Francisco, California

AMERICAN LIBERTY OIL COMPANY
Dallas, Texas

ANDERSON-PRICHARD OIL CORP.
Oklahoma City, Oklahoma

ANGLO-IRANIAN OIL CO. LTD.
London, England

ASHLAND OIL & REFINING CO.
Ashland, Kentucky

BERRY ASPHALT COMPANY
Magnolia, Arkansas

BRITISH AMERICAN OIL CO. LTD.
Toronto, Ontario, Canada

BYERLYTE CORPORATION
Cleveland, Ohio

CARTER OIL COMPANY
Billings, Montana

CITIES SERVICE OIL COMPANY
New York, N. Y.

COL-TEX REFINING COMPANY
Oklahoma City, Oklahoma

COSDEN PETROLEUM CORPORATION
Big Spring, Texas

THE DERBY OIL COMPANY
Wichita, Kansas

DOUGLAS OIL CO. OF CALIFORNIA
Paramount, California

EMPIRE PETROLEUM COMPANY
Denver, Colorado

EMPIRE STATE OIL COMPANY
Thermopolis, Wyoming

ENVOY PETROLEUM COMPANY
Long Beach, California

ESSO STANDARD OIL COMPANY
New York, N. Y.

FARMERS UNION CENTRAL EXCH.
Billings, Montana

GENERAL PETROLEUM CORP.
Los Angeles, California

HUNT OIL COMPANY
Dallas, Texas

IMPERIAL OIL LIMITED
Toronto, Ontario, Canada

KERR-MCGEE OIL INDUSTRIES, INC.
REFINING DIVISION
Oklahoma City, Oklahoma

LEONARD REFINERIES, INC.
Alma, Michigan

LION OIL COMPANY
El Dorado, Arkansas

MACMILLAN PETROLEUM CORP.
El Dorado, Arkansas
Los Angeles, California

MEXICAN PETROLEUM CORP.
New York, N. Y.

MEXICAN PETROLEUM CORP. OF GA.
Atlanta, Georgia

MID-CONTINENT PETROLEUM CORP.
Tulsa, Oklahoma

MONARCH REFINERIES, INC.
Oklahoma City, Oklahoma

AB NYNAS-PETROLEUM
Nynashamn, Sweden

PAN-AM SOUTHERN CORPORATION
New Orleans, Louisiana

PHILLIPS PETROLEUM COMPANY
Bartlesville, Oklahoma

RAFFINERIE BELGE DE PETROLES, S.A.
Anvers, Belgium

JEFF P. ROYDER
Houston, Texas

SHELL OIL COMPANY
New York, N. Y.

SHELL OIL COMPANY
San Francisco, California

SHELL PETROLEUM COMPANY LTD.
London, England

SINCLAIR REFINING COMPANY
New York, N. Y.

SOCONY-VACUUM OIL CO., INC.
New York, N. Y.

THE SOUTHLAND COMPANY
Yazoo City, Mississippi

STANDARD OIL COMPANY OF BRITISH COLUMBIA, LTD.
Vancouver, B. C., Canada

THE STANDARD OIL COMPANY
(AN OHIO CORPORATION)
Cleveland, Ohio

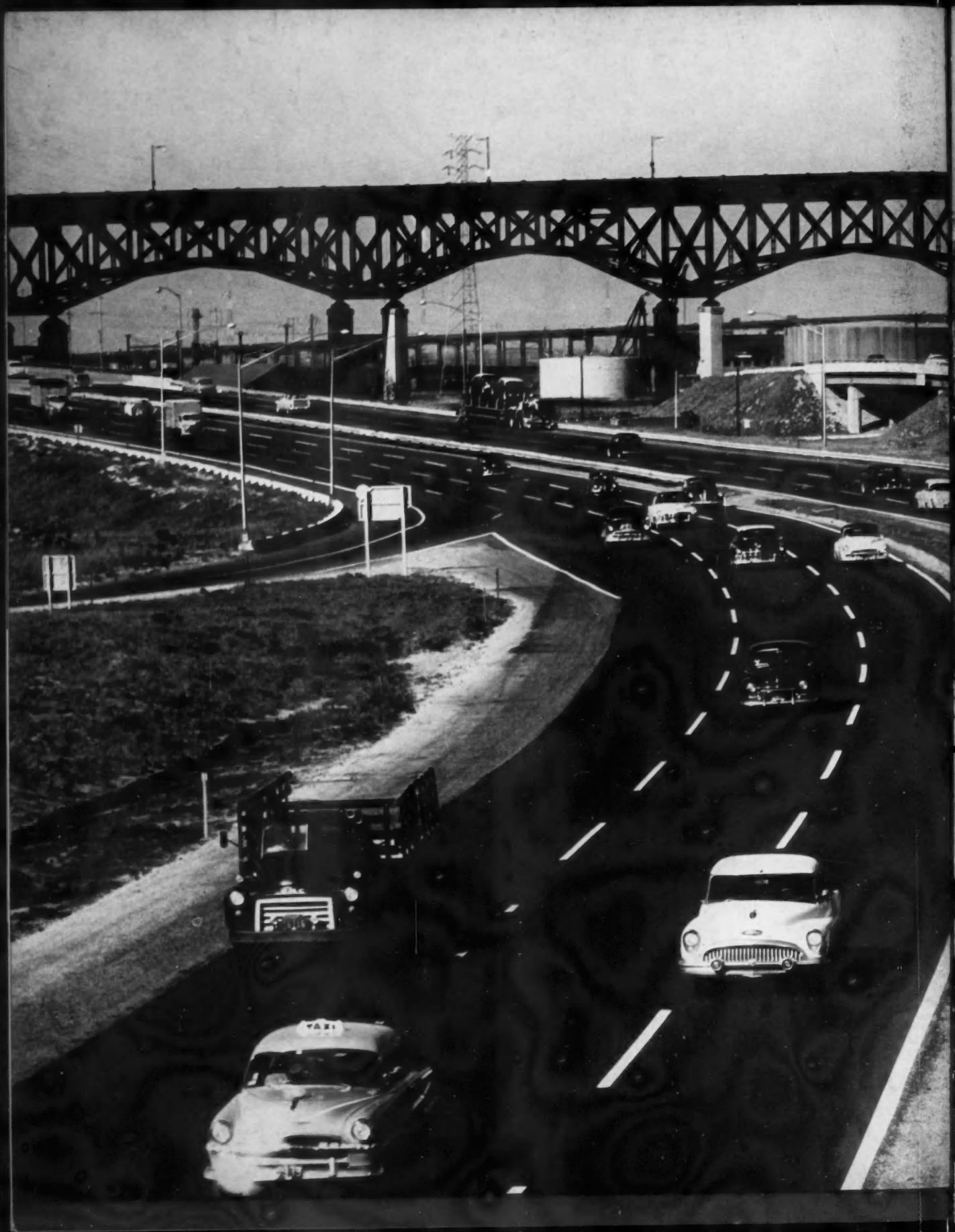
THE TEXAS COMPANY
New York, N. Y.

UNION OIL COMPANY OF CALIFORNIA
Los Angeles, California

WITCO CHEMICAL COMPANY
PIONEER ASPHALT DIVISION
New York, N. Y.

THE ASPHALT INSTITUTE
801 SECOND AVENUE • NEW YORK 17, N. Y.

Printed in U.S.A.


TAXI